EEL-2010 Programming Assignment Report

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Programming language used : Python (version 3.7)

Python Libraries used : 1. Matplotlib (to plot the graphs)
2. Pandas (to read the csv file)
3. cmath (for using mathematical functions)

Aim:

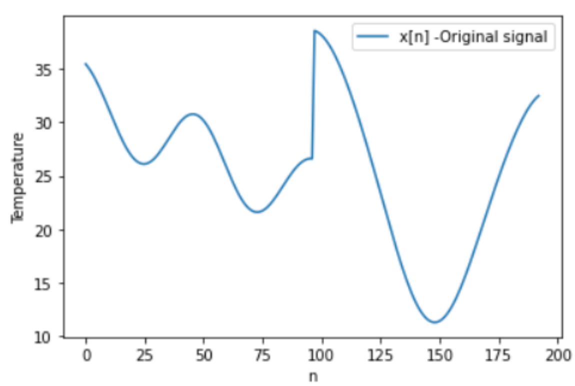
To implement the following two approaches to recover the original signal x[n] from distorted signal y[n].

1. First remove noise and then sharpen (deblur).
2. First sharpen (deblur) and then remove noise.

And then compare the two signals obtained to find which one is a better approach for signal processing.

Results:

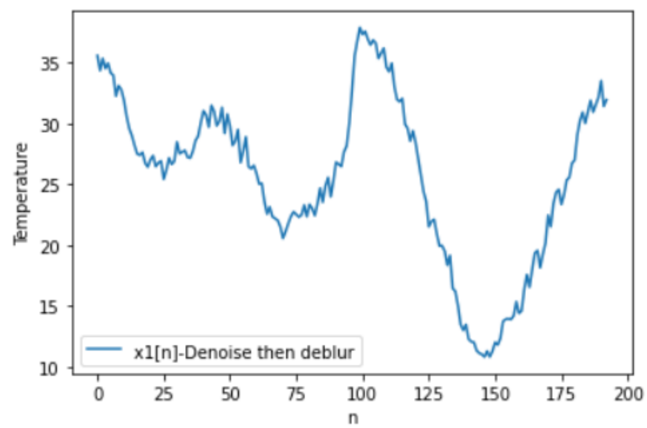
The original given signal is:



Fig(i)-Plot depicting $x[n]$, the original given signal

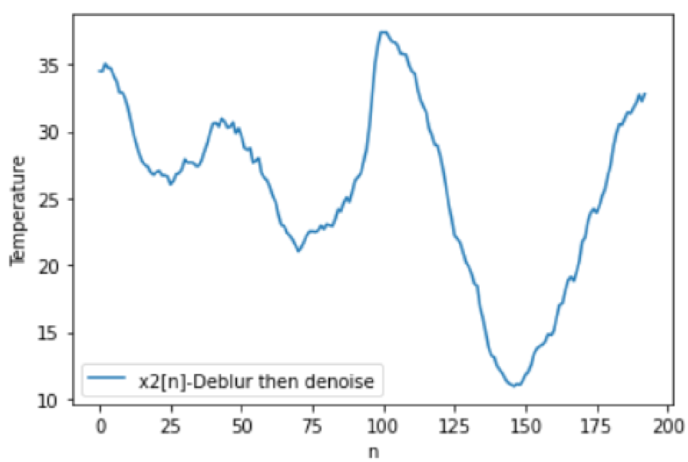
On performing the above two ways of signal processing, the following results were obtained:

- <u>Case-I:</u> Remove noise and then sharpen (deblur)

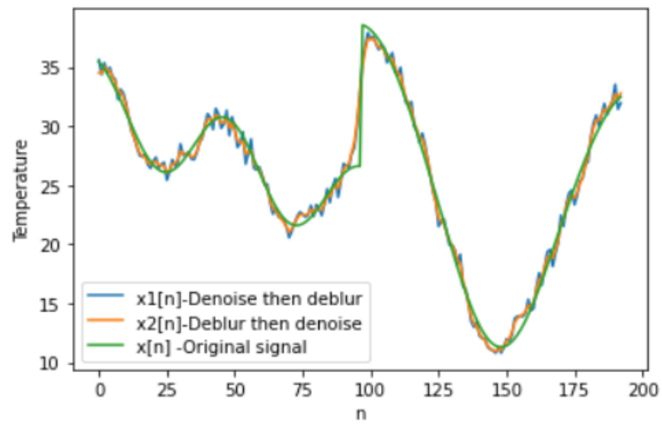


Fig(ii)-Plot depicting $x_1[n]$

- <u>Case-II:</u> Sharpen (deblur) and then remove noise



Fig(iii)-Plot depicting $x_2[n]$



Fig(iv)-Plot depicting $x_1[n]$, $x_2[n]$ & $x[n]$, all three together

Theoretical explanations:

Noise : In signal processing, noise is an unwanted signal that comes with the signal of our interest. It is generally of frequency that is much higher than the frequency of our interest. They interfere with our original signal and produce undesired random disturbances.

Denoising : This is the process to remove the noise. In this process, we used the concept of averaging. We create 3 cases :

- for n=0, we find average of y[0],y[1],y[2]
- for n=192, we find average of y[190],y[191],y[192]
- for n=1, we find average of y[0],y[1],y[2],y[3]
- for n=191, we find average of y[189],y[190],y[191],y[192]
- for 2<=n<=190, we find average of y[n-2],y[n-1],y[n],y[n+1],y[n+2]

Blurring: A sharp signal is blurred when it is convolved with the blur kernel to generate a blurred signal.

Deblurring : It is the process of removing blurring artifacts from signals. Deblurring recovers a sharp signal from a blurred one.

In this phenomenon, the original signal $x[n]$ gets distorted to $y[n]$ via convolution with $h[n]$. The following steps are performed to get the original signal:

- Performing Fourier transformation on the equation,

$$y[n] = x[n] * h[n]$$
$$\Rightarrow Y[n] = X[n]\ H[n]$$
$$\Rightarrow X[n] = Y[n] / H[n] \qquad \rightarrow \text{(i)}$$

  Using the formula,

$$X_k = \sum_{n=0}^{N-1} x_n \cdot e^{-\frac{i2\pi}{N}kn}$$

- Performing Inverse Fourier transformation on the above equation(i) using the formula,

$$x_n = \frac{1}{N} \sum_{k=0}^{N-1} X_k \cdot e^{i\frac{2\pi}{N}kn}$$

First remove noise and then sharpen :

When we first denoise and then deblur, we unintentionally introduce more noise. This happens because sharpening occurs over a denoised signal ,that means, even if there is slightest of any noise, sharpening will enhance it.

First sharpen and then remove noise :

When we did the opposite way, that is, when we first deblur (i.e. sharpen) and then denoise, it happened that the sharpening decreased and hence, the signal was not introduced to more noise and a better result was obtained.

Conclusion :

After looking at both the signals and their resemblance with the original given signal, we conclude that $x_2[n]$ **i.e. the signal which we get by first sharpening (deblurring) and then removing noise (denoising) is a better plot** as it resembles more with the original given signal.

Reason : Denoising doesn't completely remove the noise. So , when we sharpen after denoising, sharpening enhances the noise which is left in the signal. Hence, sharpening before denoising is a better way of signal processing.

Contribution of each member :

Abhinav Singh Tawar (B20CI004) :
Contributed in -

- Coding part for deblurring the signal(deblur() function).
- Logic for finding the fourier transform of y[n] and h[n].
- Logic for finding the inverse fourier transform of X[n].
- Making the report.

Vedant A Sontake (B20ME078) :
Contributed in-

- Coding part for Denoising the signal(denoise() function).
- Logic of denoise function code.
- Making a Readme.md file.
- Making the report.

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